CLAIMS

1. A method for desymmetrization, comprising:

providing a molecular substrate having a plane of symmetry; and

causing an olefin metathesis reaction involving the molecular substrate to occur to form a product free of a plane of symmetry.

2. A method as in claim 1, wherein the desymmetrization is a catalytic desymmetrization and the providing step further comprises providing a catalyst.

3. A method as in claim 1, wherein the molecular substrate is selected from the group consisting of achiral and meso substrates.

4. A method as in claim 1, wherein the molecular substrate is selected from the group consisting of cyclic and acyclic substrates.

5. A method as in claim 1, wherein the product is selected from the group consisting of cyclic and acyclic products.

6. A method as in claim 1, wherein the product includes at least one ring having a ring size of less than about 20 atoms.

7. A method as in claim 1, wherein the product includes at least one ring having a ring size of less than about 10 atoms.

8. A method as in claim 2, wherein the catalyst is present in an amount of less than about 15 mol%, relative to an amount of substrate.

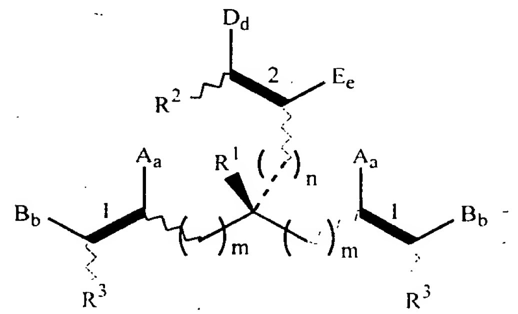
9. A method as in claim 8, wherein the catalyst is present in an amount of less than about 10 mol%.

10. A method as in claim 8, wherein the catalyst is present in an amount of less than about

5 mol%.

11. A method as in claim 8, wherein the catalyst is present in an amount of less than about 1 mol%.

12. A method as in claim 1, wherein the molecular substrate comprises a structure:



wherein "1 ❙" and "2❙" can be the same or different and each of "1 ❙" and "2❙" denotes a bond selected from the group consisting of a double bond and a triple bond; a, b, d, and e can be the same or different and each of a, b, d and e is an integer equaling 0 to 1; m and n can be the same or different and each of m and n are integers equaling 0-20; A, B, D, E and R^1 - R^3 can be the same or different and each of A, B, D, E and R^1 - R^3 is selected from the group consisting of hydrogen, hydroxy, C_1-C_{20} alkyl, C_1-C_{20} alkenyl, C_1-C_{20} aryl and C_1-C_{20} alkynyl, wherein C_1-C_{20} alkyl, C_1-C_{20} alkenyl, C_1-C_{20} aryl and C_1-C_{20} alkynyl are hydrocarbons optionally interrupted by a functional group including at least one non-carbon element.

13. A method as in claim 12, wherein each of m and n are integers equaling 0-10.

14. A method as in claim 12, wherein the functional group including at least one non-carbon element is selected from the group consisting of O, S, Se, silane, silyl ether, carbonyl, carboxyl, carboxylate, ether, ester, anhydride, acyl, cyano, NO_2, alkyloxy, aryloxy, hydroxy, hydroxyalkyl, amino, alkylamino, arylamino, amido, thioalkyl, thioaryl, sulfonate, phosphate, phosphonate, phosphane and stannane.

15. A method as in claim 1, wherein the molecular substrate comprises a structure:

least 80 % optical purity, M is a transition metal ion, and R^1 and R^2 can be the same or different, and each is selected from the group consisting of C_1-C_{12} alkyl, heteroalkyl, aryl, heteroaryl and adamantyl.

60. A method as in claim 59, wherein R^1 is selected from the group consisting of 2,6-dimethylphenyl, 2,6-diethylphenyl and 2,6-diisopropylphenyl and R^2 is selected from the group consisting of methyl, ethyl and phenyl.

61. A method for desymmetrization, comprising:

providing a molecular substrate having a plane of symmetry; and

allowing a desymmetrization reaction to occur in the absence of solvent to form a product free of a plane of symmetry.

62. A method as in claim 61, wherein the desymmetrization is a catalytic desymmetrization and the providing step further comprises providing a catalyst.

63. A method as in claim 61, wherein the desymmetrization reaction is a carbon-carbon bond forming reaction.

64. A method as in claim 63, wherein the desymmetrization reaction is an olefin metathesis reaction.

65. A method as in claim 64, wherein the olefin metathesis reaction is selected from the group consisting of a ring-closing and a ring-opening reaction.

66. A method as in claim 64, wherein the molecular substrate is a first molecular substrate, the method further comprising a second molecular substrate and the olefin metathesis reaction is a cross-metathesis reaction.

67. A method as in claim 62, wherein the desymmetrization reaction causes at least one enantiomer of a product to form in an enantiomeric excess of at least about 20% at a turnover number of at least about 5.

68. A method as in claim 67, wherein the at least one enantiomer is formed in an enantiomeric excess of at least about 50%.

69. A method as in claim 67, wherein the at least one enantiomer is formed in an enantiomeric excess of at least about 85%.

70. A method as in claim 67, wherein the at least one enantiomer is formed in an enantiomeric excess of at least about 90%.

71. A method as in claim 67, wherein the at least one enantiomer is formed in an enantiomeric excess of at least about 95%.

72. A method as in claim 67, wherein the at least one enantiomer is formed in an enantiomeric excess of at least about 99%.

73. A method as in claim 67, wherein two enantiomers are formed in an enantiomeric excess of at least about 20%.

74. A method for catalytic desymmetrization, comprising:

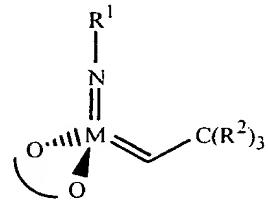
providing a molecular substrate having a plane of symmetry and a catalyst; and

allowing a desymmetrization reaction to occur to form a product having a quaternary carbon center in at least about 20% enantiomeric excess.

75. A method as in claim 74, wherein the desymmetrization reaction is a carbon-carbon bond forming reaction.

76. A method as in claim 75, wherein the desymmetrization reaction is an olefin metathesis reaction.

77. A composition comprising a structure:



wherein M is a metal ion and  is a chiral dialkoxide of at least 80 % optical purity, the dialkoxide having sufficient rigidity such that a  reaction site is of sufficient shape specificity, defined in part by the dialkoxide and a M=N-R site, to cause a molecular substrate having a plane of symmetry to react with a M=C center at the  reaction site, forming a catalytic olefin metathesis product that has at least a 50 % enantiomeric excess of at least one enantiomer present in the mixture, the product being free of a plane of symmetry.

78. A method for performing a kinetic resolution, comprising:

providing at least one substrate having at least one olefin group;

selecting a catalyst of sufficient steric bulk to initiate an olefin metathesis reaction involving the at least one substrate to achieve a k_{rel} of at least about 10.

79. A method as in claim 78, wherein the reaction is selected from the group consisting of a ring-opening metathesis reaction, a cross-metathesis reaction and a ring-closing metathesis reaction.

80. A method for performing an asymmetric olefin metathesis reaction, comprising:

providing a substrate comprising at least one olefin group associated with a ring structure;

reacting a catalyst with the substrate to initiate an olefin metathesis reaction to achieve a k_{rel} of at least about 5.

81. A method as in claim 80, wherein the reaction further comprises a kinetic resolution.

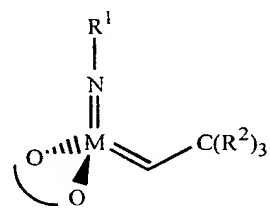
82. A method for performing an asymmetric olefin metathesis reaction, comprising:

providing two substrates, each substrate containing at least one olefin group;

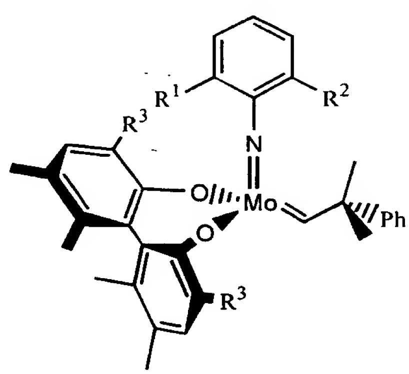
reacting a catalyst with the substrates to form a product having an enantiomeric excess of at least about 50%.

83. A method as in claim 82, wherein the reaction is selected from the group consisting of a ring-opening metathesis reaction, a cross-metathesis reaction, kinetic resolution and a combination thereof.

84. A method as in any one of claims 78, 80 or 82 wherein the catalyst comprises a structure:



85. A method as in claim 84, wherein the catalyst comprises a structure:



wherein R^1 - R^3 can be the same or different and each is selected from the group consisting of hydrogen, alkyls, aryls, alkaryls and substituted derivatives thereof.

86. A method as in claim 85, wherein R^3 is selected from the group consisting of ethyl, *i*-Pr, *t*-Bu and adamantyl and R^1 and R^2 selected from the group consisting of i-Pr and methyl.

87. A method as in claim 85, wherein R^1 is CF_3 and R^2 is hydrogen.